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PRELIMINARY DRAFT
FOR REVIEW PURPOSES ONLY

SAN JOSE PERMIT ASSISTANCE PROGRAM
SALT MARSH HARVEST MOUSE
1990 TRAPPING SURVEYS

PROGRESS REPORT

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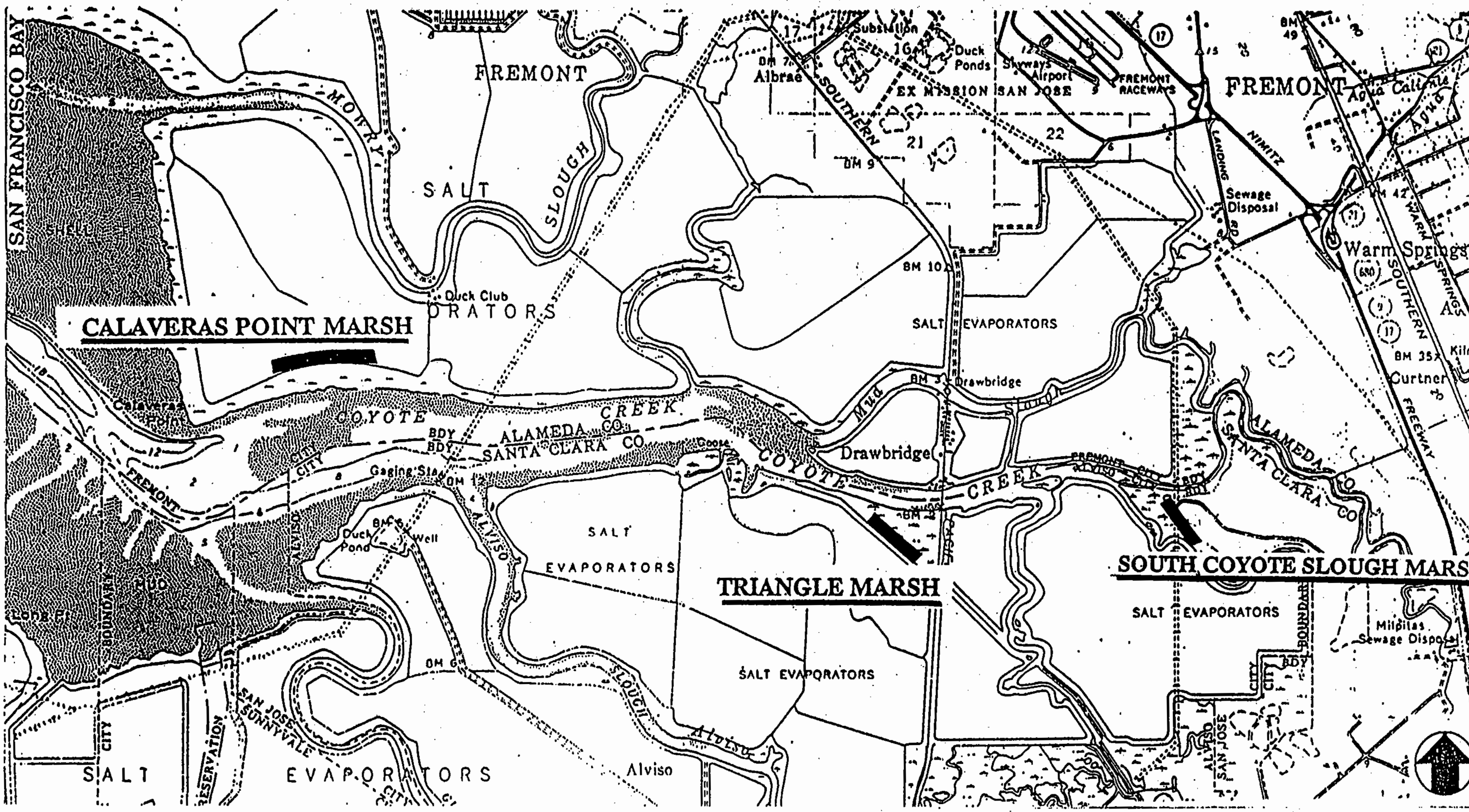
EXECUTIVE SUMMARY

Three marshes in the south end of the San Francisco Bay, CA were surveyed for salt marsh harvest mice (SMHM) as well as for other small mammals (Figure 1). The three marshes varied in salinity: Calaveras Point contained a salt marsh, Triangle Marsh contained a transitional marsh, and Newby Island contained a brackish marsh. Ninety-five individual salt marsh harvest mice were trapped at Calaveras Point. Fifty-nine individual SMHM were trapped on the marsh plain, 36 individual SMHM were trapped on the levee, and an additional nine SMHM that were originally caught on the marsh plain were caught on the levee one week later after the trapping on the marsh plain. Twenty-nine SMHM were trapped at the transitional marsh Triangle Marsh. Fourteen individual SMHM were trapped on the marsh plain, 15 individual SMHM were trapped on the levee, and an additional six SMHM that were originally caught on the marsh plain were caught on the levee during the second week. Zero SMHM were trapped on the marsh plain at Newby Island, and two SMHM were trapped on the levee the follwing week. Order of abundance of SMHM ranked from highest to lowest were Calaveras Point, Triangle Marsh, and Newby Island.



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SALT MARSH HARVEST MOUSE TRAPPING AREAS 1990

File No. 477-11	Date 6/4/90	Figure 1

INTRODUCTION

H. T. Harvey and Associates conducted a survey for the federally endangered salt marsh harvest mouse (*Reithrodontomys raviventris*) at various marshes in the southern section of the San Francisco Bay area (Figure 1). These marshes were characterized as salt, transitional, and brackish - all with floras characteristic of their respective marshes. Surveys were conducted in April 1990 at Calaveras Point, in May 1990 at Triangle Marsh, and in June 1990 at Newby Island during the lowest high tides on the marsh plain. Flora at each marsh were also identified and measured.

This progress report summarizes the work performed by wildlife biologists and botanists from H.T. Harvey and Associates as of June 29, 1990. More detailed methods, results, and discussions will be included in the final report.

METHODS

FIELD AREA

The study site consisted of three marshes located in the south section of San Francisco Bay (Figure 2). Calaveras Point, a salt marsh consisting of mainly pickleweed (*Salicornia virginica*), was trapped April 17 through April 29, 1990 (Figure 3). Triangle Marsh, a transitional marsh, consisting of pickleweed, perennial peppergrass (*Lepidium latifolium*), alkali heath (*Frankenia grandifolia*) and alkali bulrush (*Scirpus robustus*) (Figure 4), was trapped May 14 through May 25, 1990. Newby Island, a brackish marsh consisting of mainly alkali bulrush, was trapped June 13 - 15, June 18 - 23, and June 27 - 29, 1990.

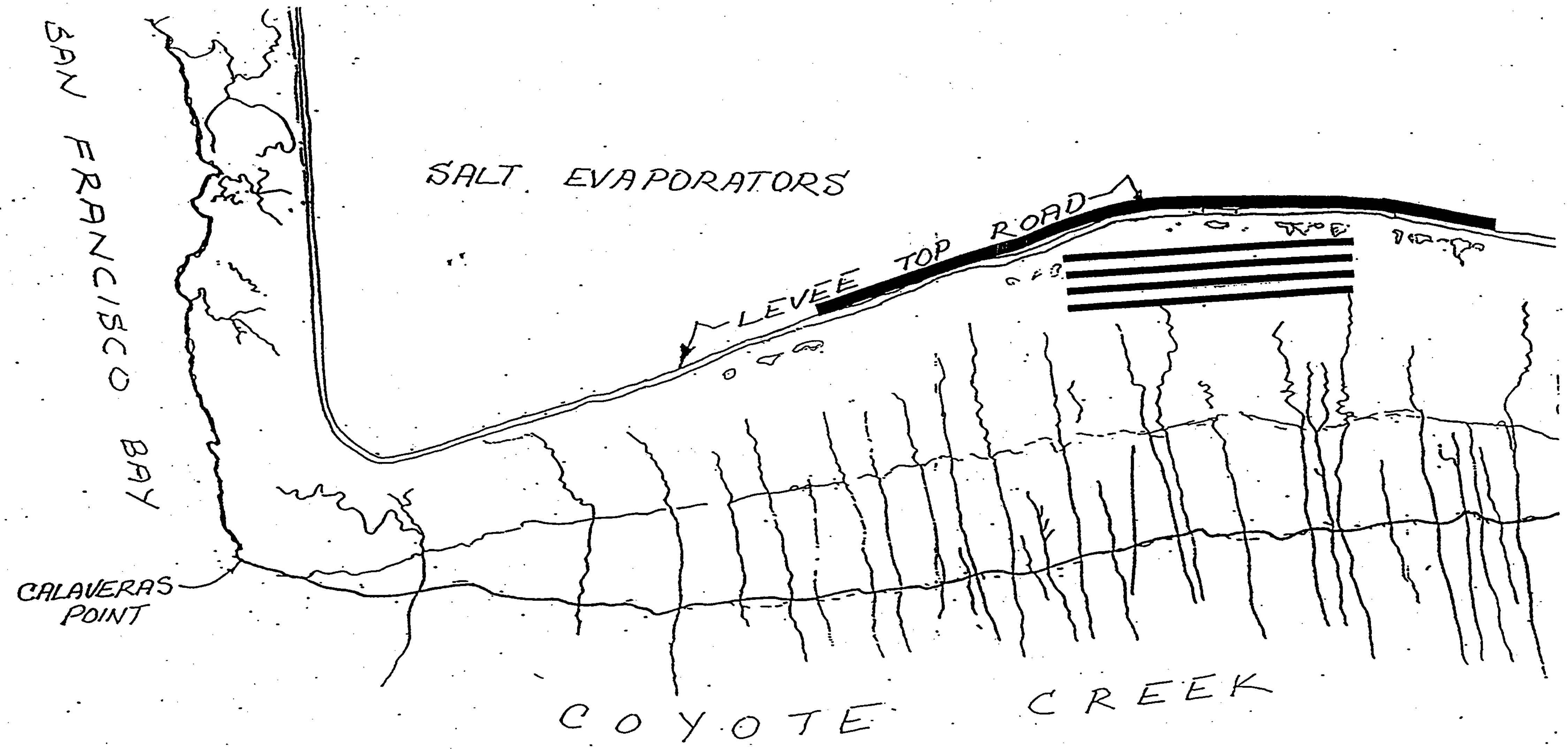
The trapping regime for Calaveras Point and Triangle Marsh consisted of placing 100 traps in a grid pattern adjacent to the levee on the marsh plain and trapping for five nights, then placing 100 traps along the levee and trapping for five nights. The grid pattern for Calaveras Point and Triangle Marsh was a 4 trap X 25 trap rectangle (30 m X 240 m) with traps spaced 10 meters apart. Trap placement pattern on each levee was one line of traps placed 5 m apart such that the line extended past the edges of the grids. The grid pattern for Newby Island was, for a majority of the grid, a 4 trap X 10 trap rectangle with extra traps placed around the marsh dependent on slough locations. Due to tidal constraints the marsh plain was trapped for three consecutive nights with 64 traps per night. Two weeks later the marsh plain was trapped for two consecutive nights with 100 traps per night. Total number of trap nights on the marsh plain was 392. The trap placement pattern on the levee was one line of traps placed 5 m apart such that the line extended past the edges of the grids.

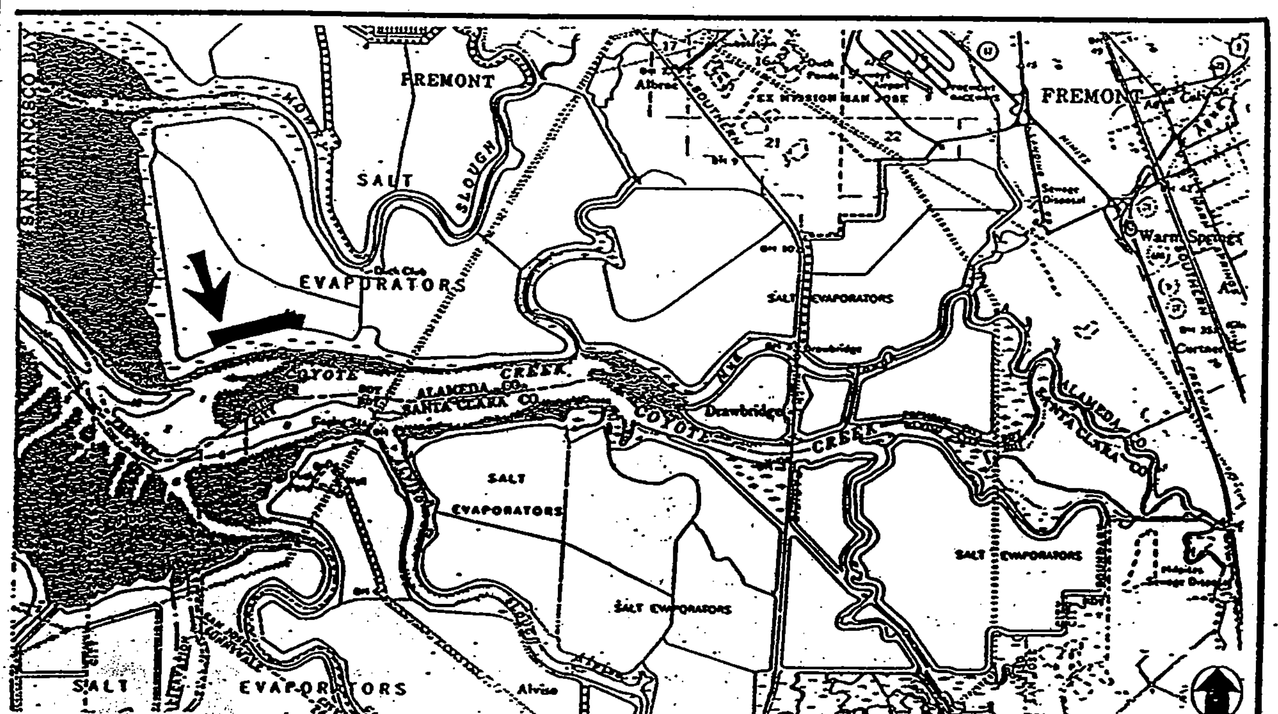
ANIMALS

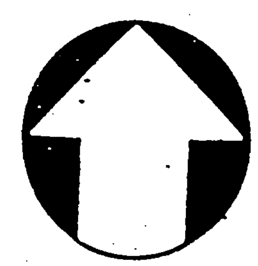
Sherman live-traps were checked each morning at sunrise, closed during the day, and then opened each evening within sixty minutes before sundown. Each trap was covered with vegetation to reduce solar heating and nocturnal heat loss, and provided with nesting material and bait. Salt marsh harvest mice were identified using the characteristics described in the following section, uniquely tagged, weighed, sexed, and location recorded. All other small mammal species were uniquely tagged, weighed, sexed, and location recorded.

IDENTIFICATION OF SALT MARSH HARVEST MICE

The salt marsh harvest mouse is difficult to identify in the field due to the morphological







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TRAP LINES

CALAVERAS POINT EAST I MARSH

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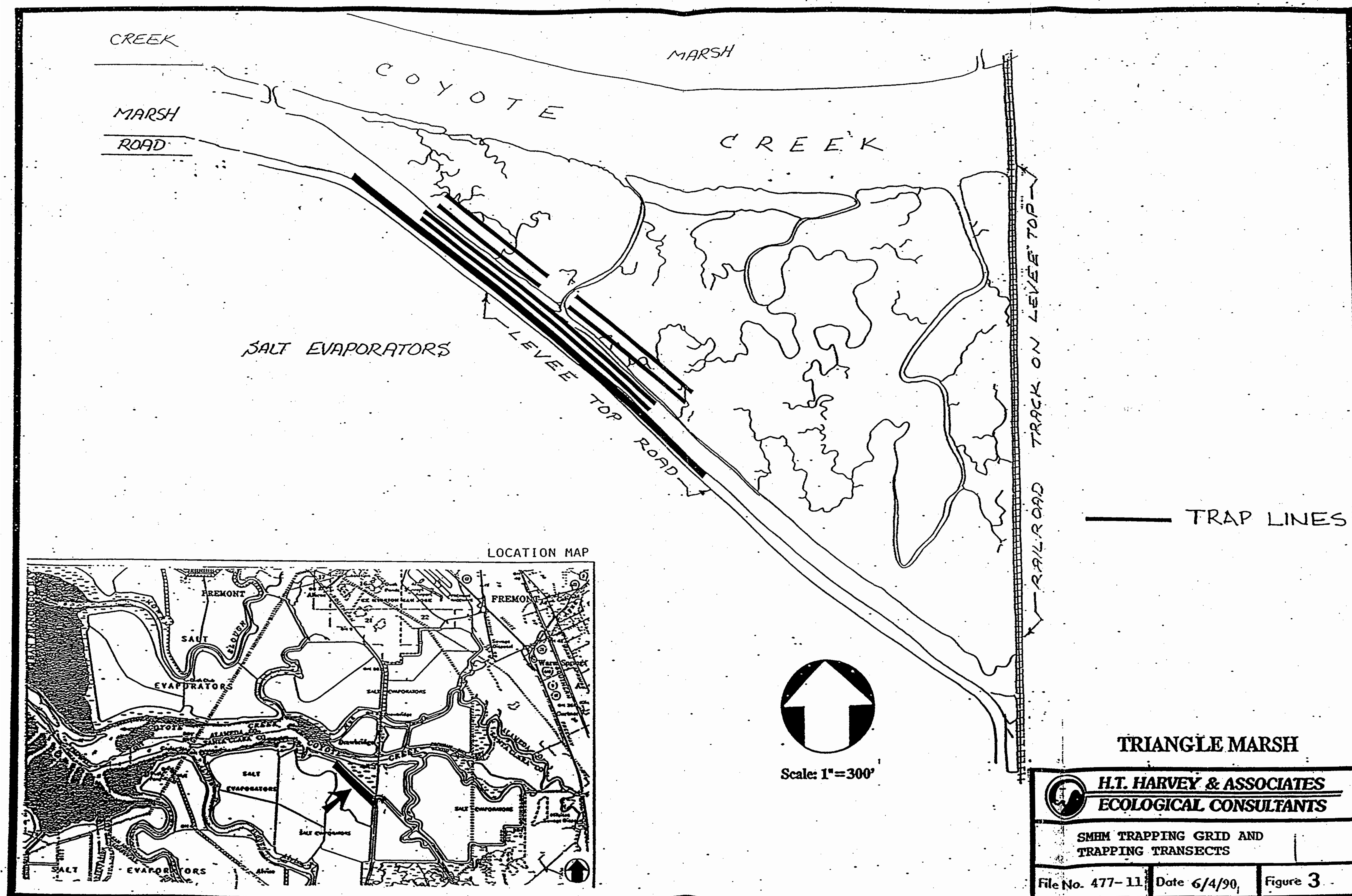
SMHM TRAPPING GRID AND TRAPPING TRANSECTS

File No.	Date 6/4/90	Figure 2



TRIANGLE MARSH

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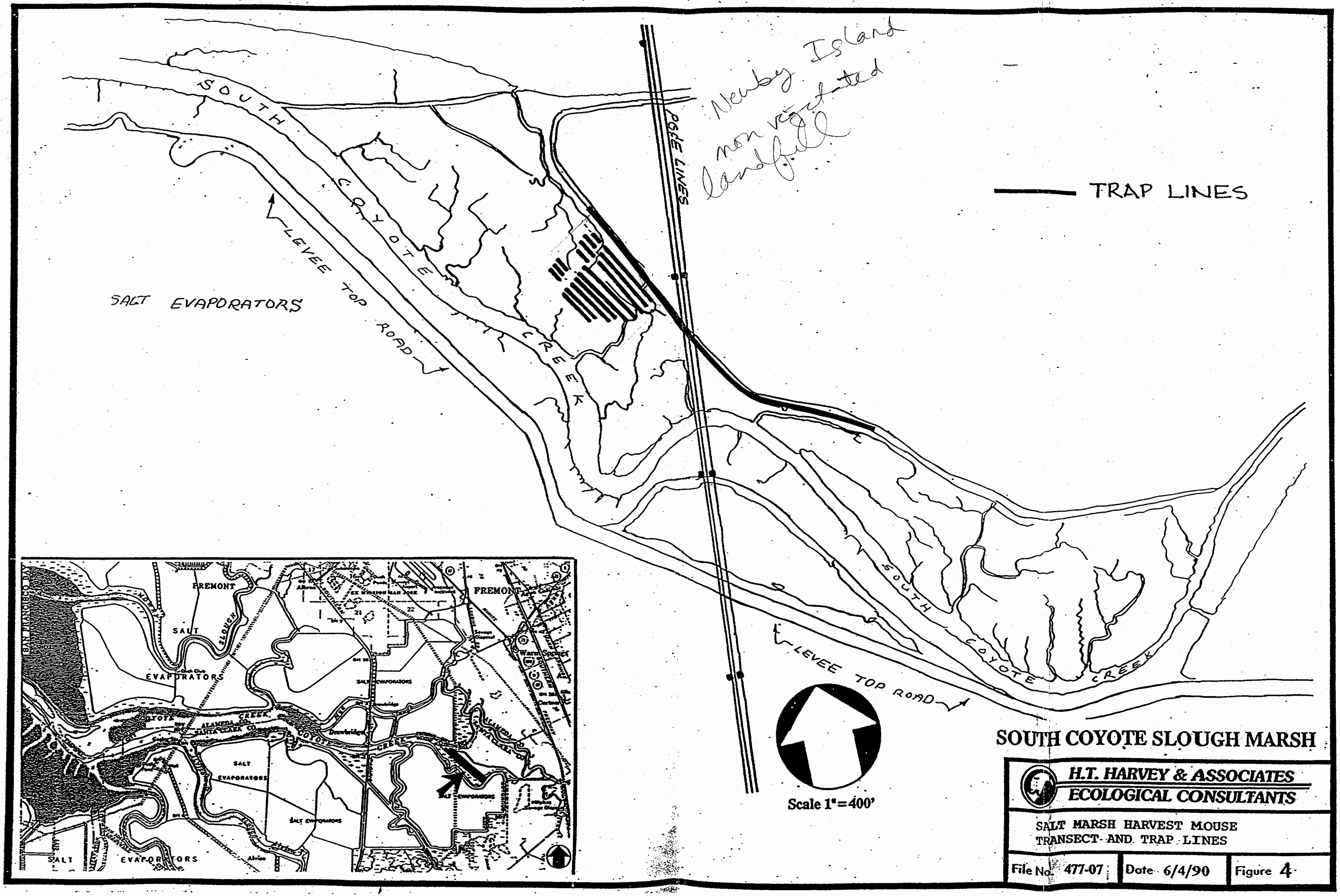
SMHM TRAPPING GRID AND TRAPPING TRANSECTS

File No. 477-11 | Date 6/4/90 | Figure 3


Newby Island
non vegetated
landfill
PG&E LINES
TRAP LINES
SOUTH
COYOTE
CREEK
LEVEE TOP ROAD
SALT EVAPORATORS
SOUTH
COYOTE
CREEK
LEVEE TOP ROAD
FREMONT
FREMONT
SALT
EVAPORATORS
SALT
EVAPORATORS
SALT EVAPORATORS
SALT
EVAPORATORS
Scale 1"=400'
SOUTH COYOTE SLOUGH MARSH
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SALT MARSH HARVEST MOUSE
TRANSECT AND TRAP LINES
File No. 477-07
Date 6/4/90
Figure 4

similarities it shares with the common and widespread western harvest mouse (*Reithrodontomys megalotis*). In an extensive study of these two species, Fisler (1965) described criteria used in their identification. Dr. Howard Shellhammer, after many years of field investigations of the salt marsh harvest mouse, published a paper detailing the technique used to accurately identify this species, (Shellhammer, 1984). A brief summary follows.

Characteristics of the tail provide the most reliable means for differentiating between salt marsh and western harvest mice. Specifically, the pointedness of the tip of the tail, the overall color pattern and presence of white hairs on the ventral side of the tail, and the diameter of the tail 20mm from the body are all carefully recorded for proper identification. Shellhammer (1984) developed a numeric system to rank the values of these characteristics. Total score for an individual can range from 0 - 8. Salt marsh harvest mice generally score from 0 - 3 while Western harvest mice typically score from 6 - 8. The behavior of the animals aids in diagnosis and is used in addition to the morphological characteristics.

VEGETATION

Following the conclusion of each trapping episode the vegetation was characterized by measuring percent cover and height at every other trap site and at each capture site. Vegetation was sampled by taking twenty point-intercept points within a one meter square quadrat (1 m^2) centered on a trap site. Four heights were taken at previously chosen locations in each quadrat. Measurements were processed to obtain average vegetation information for all trap sites at each transect, and at all capture sites.

RESULTS

Calaveras Point

Ninety-five individual salt marsh harvest mice (SMHM) were caught using a total of 1000 trap nights within the two week trapping episode. Trap nights were calculated by multiplying the total number of traps by the number of nights. Table 1 summarizes numbers of animals caught on the marsh plain during the first week, and numbers of animals caught on the levee during the second week. The number of animals caught during the second week includes newly tagged animals and animals that were tagged during the previous week, i.e. nine of the forty-five animals caught on the levee were caught during the previous week on the marsh plain. In order to standardize these results the value "trap effort" was calculated by dividing a given number of trap nights (TN) by the number of animals trapped. Trap effort on the marsh plain for 500 trap nights was 8.5 TN/1 SMHM. Trap effort on the levee for 500 trap nights was 11.1 TN/1 SMHM. Capture efficiency is the reciprocal of trap effort and is useful for comparing results between marshes. Capture efficiency on the marsh plain was 0.118, and on the levee was 0.090.

Capture sites on the marsh plain consisted of pickleweed with absolute cover approximately 100%, and capture sites on the levee consisted of pickleweed and a small amount of other plants (Table 2). All of the SMHM caught on the marsh plain were caught in pickleweed, and SMHM caught on the levee were caught in vegetation dominated by pickleweed.

Triangle Marsh

Twenty-nine SMHM were caught using a total of 1500 trap nights during the two week trapping episode. The levee was trapped during both weeks for a total of 1000 trap nights because the second week of trapping occurred during the highest high tides of the year. Trapping the levee prior to the highest tides afforded a comparison between tides. Six of the animals caught on the levee (Table 1) were first caught on the marsh plain. Trap effort on the marsh plain for 500 trap nights was 35.7 TN/ 1 SMHM (CE = 0.028). Trap effort on the levee for 1000 trap nights was 47.6 TN/ 1 SMHM (CE = 0.021).

Capture sites on the marsh plain consisted of a mixture of plant species including pickleweed, alkali bulrush, and broad-leaf pepper-grass (Table 2). Nine of the 14 SMHM caught on the marsh plain were caught in vegetation dominated by pickleweed, and five of the 14 SMHM caught on the marsh plain were trapped in areas of bulrush that were adjacent to pickleweed patches. Capture sites on the levee were dominated by pickleweed, alkali heath, and fathen (*Atriplex patula*).

Table 1: Summary of Captures.

SITE	SALT MARSH HARVEST MOUSE		VOLE		HOUSE MOUSE		DEER MOUSE	
	NEW (1)	PREV (2) TAG	NEW	PREV TAG	NEW	PREV TAG	NEW	PREV TAG
CALAVERAS POINT								
A. Marsh Plain	59		7		0		0	
B. Levee	45 (3)	9	86	4	6		0	
TRIANGLE MARSH								
A. Marsh Plain	14		40		0		0	
B. Levee (Week 1)	4		6		1		2	
(Week 2)	17 (3)	6	46	13	4		4	
NEWBY ISLAND								
* A. Marsh Plain	0		0		9		0	
B. Levee	2		0		13	0	0	

(1) First-time captures within a trapping session

(2) Individuals tagged on Marsh Plain and then subsequently captured on levee.

(3) Includes previously tagged animals from the plain see (2)

* 392 trap nights, due to tidal constraints--all other sessions consist of 500 trap nights.

Table 2: Capture site vegetation characteristics summary

	LEVEE		MARSH PLAIN	
Calaveras Point	AC	RC	AC	RC*
Pickleweed	51.6	74.5	99.5	100
Salsola soda	7.6	10.8	--	--
Perennial Peppergrass	6.5	6.4	--	--
Beet	2.5	4.0	--	--
Iceplant	0.4	2.0	--	--
Alkali Heath	1.8	2.0	--	--
Common Sow Thistle	0.2	0.3	--	--
Total	70.0	100	99.5	100
Mean Height (cm)	24.8		23.6	
Litter	87.1		27.7	
Bare Ground	5.9		0.0	
Triangle Marsh				
Pickleweed	28.5	39.2	72.5	58.7
Alkali Bulrush	--	--	22.5	20.4
Five-hook Bassia	1.5	1.3	6.9	3.9
Marsh Grindelia	--	--	0.6	0.4
Perennial Peppergrass	12.0	11.4	10.6	6.8
Alkali Heath	15.0	26.9	14.4	8.0
Fathen	18.0	19.9	--	--
Cressa	1.5	1.4	2.5	1.8
Total	76.5	100	130.0	100
Mean Height (cm)	15.5		47.6	
Litter	59.5		66.9	
Bare Ground	25.9		1.3	
Newby Island				
Iceplant	15.0	28.4	(no captures)	
Broad-leaf Pepper-grass	35.0	63.4		
Australian Saltbush	5.0	8.4		
Total	55.0	100		
Mean Height (cm)	31.8			
Litter	20.0			
Bare Ground	50.0			

* AC - Absolute cover
RC - Relative cover

Newby Island

Two SMHM were caught using a total of 892 trap nights during the trapping episode. Placement of traps on the marsh plain were limited due to tidal fluctuations and slough locations, thus total number of trap nights on the plain was 392. All traps on the marsh plain were removed every day, and then replaced at the nighttime setting. Placement of traps on the levee were not limited by the tides so traps were not moved, and total number of trap nights was 500. Zero SMHM were caught on the marsh plain (CE = 0.0). Trap effort on the levee for 500 nights was 250 TN/ 1 SMHM (CE = 0.004).

Vegetation on the marsh plain consisted of 100% alkali bulrush. The two SMHM caught on the levee were trapped in patches dominated by perennial peppergrass and iceplant (*Mesembryanthemum* spp) (Table 2).

DISCUSSION AND CONCLUSIONS

Two hypotheses were tested in this study, namely, salt marshes have higher densities of SMHM than the transitional or brackish marshes, and, levee trapping adjacent to the above three types of marshes will show the same pattern. The single effort made here may qualitatively support the hypothesis but should not be translated into quantitative certitude.

Trapping results from either the marsh plains or from the levees can be used to rank marshes relative to each other: the salt marsh at Calaveras Point had the most SMHM followed by the transitional marsh at Triangle Marsh, and then the brackish marsh at Newby Island. Capture efficiency on the marsh plain at Calaveras Point was about 4 times higher compared to the marsh plain at Triangle Marsh (0.118/0.028), and infinitely higher compared to Newby Island (0.118/0). Capture efficiency on the levee at Calaveras Point was about 4 times higher compared to the levee at Triangle Marsh (0.090/0.021), and about 22 times higher compared to the levee at Newby Island (0.090/0.004). But, because this trapping was done only once in each habitat type extrapolating to all of a given marsh or other marshes is premature.

Results from trapping on marsh plains and then on levees revealed that levee trapping was not a good estimator of habitat use and relative abundances on the marsh plain. Capture efficiencies were higher on the marsh plains compared to the levees at both Calaveras Point and Triangle Marsh (1.3 times). If the capture efficiencies on the levee at Triangle Marsh are separated by each week then the ratio between the marsh plain and the levee is either 3.5 times higher for the first week (0.028/0.008) or 0.8 times higher for the second week (0.028/0.034). The second week at Triangle Marsh was the week of highest tides for the year, thus many mice were likely forced to move to the levee. Since the area of a marsh plain is greater than the area of a levee, and trapping results on marsh plains are not reflected in trapping results on levees the marsh plains of tidal marshes must be trapped in order to determine habitat use and relative abundance of salt marsh harvest mice in such areas. Trapping on the levees gives a partial, and probably nonuniform, distribution of the mice in the entire marsh.

Numbers of SMHM from the marsh plain at Calaveras Point were among the highest ever recorded. Comparable capture efficiencies (CE) were recorded in 1985 at a tidal marsh on Mare Island (Kovach and Voigt 1986). Capture efficiencies were 0.53, 0.39, and 0.13 at three locations within the marsh. In 1972 Wondolleck et al. recorded a CE = 0.10 in a tidal marsh, and in 1988 Geissel et al. documented a CE = 0.023 on a diked marsh. Thus, capture efficiency at Calaveras was relatively very high. Capture efficiency at Triangle

Marsh was average to low, and very low at Newby Island. The high number of SMHM at Calaveras may have indicated a seasonal or yearly peak in abundance, or could have been an average number for that population. More trapping will be necessary to determine which interpretation to use.

Even though SMHM were caught in alkali bulrush at Triangle Marsh we do not know to what extent these animals were using the non-pickleweed habitats. The alkali bulrush locations were situated approximately 60 feet from the nearest pickleweed; sometimes a ditch separated the bulrush from the nearest pickleweed. These results suggest that SMHM may be able to use non-pickleweed patches as long as there is pickleweed nearby. Further work will be necessary to determine microhabitat use, or to ascertain whether SMHM use alkali bulrush only for transit between areas of pickleweed.

SUGGESTIONS FOR FUTURE WORK

H. T. Harvey and Associates recommends the following studies:

1. Trap for SMHM at different locations in all marsh types, and trap at original locations during different seasons to determine variability in relative abundance within marsh habitat types.

2. Establish two grids at different distances from the levee to determine SMHM distribution within a marsh plain.

3. Radio-collar SMHM to discover microhabitat use in both a transition marsh and a salt marsh.

4. Trap along levees of brackish marshes to test if levees are used as dispersal corridors to more suitable habitat.

RATIONALE

1. This first set of data supports the contention that pickleweed is optimum SMHM habitat, but more data are necessary to determine if these data are representative of all marshes. Other salt, transitional, and brackish marshes, used as replicates, might reflect high or low variability within salinity conditions. Without further studies the natural variability within treatments is unknown. Also, Calaveras Point data may represent a seasonal peak in the resident SMHM population. Additional trapping in the fall at Calaveras Point and Triangle Marsh may reveal a lower number of animals as these populations are thought to vary seasonally. Without additional data such seasonal variation can not be verified.

Additional data are necessary to assist with the Habitat Evaluation Procedure (HEP) in developing a reliable Habitat Suitability Index (HSI) model useful for mitigation. An understanding of seasonal variation will help to determine if the high numbers of SMHM at Calaveras Point are typical or atypical of that habitat type. If other salt marsh areas indicate that Calaveras Point was atypical then the mitigation requirement for salt marsh conversion might be lower. If Calaveras Point was typical of salt marshes then the mitigation requirement could be high.

2. SMHM may not be distributed equally throughout the marsh plain. By placing two grids on a marsh plain, one adjacent to the levee and one closer to the bay, the relative

density distribution of SMHM within the marsh plain can be better mapped. The exact mechanism for uneven distribution is unknown, but by trapping in various areas within the plain the results may indicate where SMHM are most abundant. Once distribution is known then various factors, marsh plain elevations and tidal inundations to name a few, could be correlated to assist in determining habitat preferences. These results would alter the size of the area listed as affected SMHM habitat.

If SMHM are not distributed equally throughout the marsh plain then the preferred area contained within the marsh plain will be smaller than the entire marsh. This smaller affected area would result in a reduction in the required mitigation acreage.

3. Radio tracking studies of SMHM would provide a more detailed analysis of micro-habitat preference. SMHM may use bulrush habitat as well as pickleweed habitat. If they do, then the area of suitable habitat may be larger than traditionally accepted.

SMHM may use bulrush habitat as well as pickleweed habitat. If they do, then the area of suitable habitat may be larger than traditionally accepted. Such findings may alter the amount of mitigation. If radio tracking indicates that SMHM avoid or lightly use alkali bulrush then the results will support existing data.

4. Existing results indicate that brackish marshes are not suitable for SMHM. However, the levees adjacent to salt marshes may provide shelter for SMHM as they travel from marsh to marsh. This shelter would be a travel corridor that connects isolated marshes throughout the area.

If SMHM use the habitat along the levee in brackish marshes then the habitat may have biological value. This levee habitat may be important in aiding dispersing SMHM when they search for suitable habitat. If SMHM do move between small marshes via brackish marsh levees then the value of the small marshes is increased. If SMHM do not appear to use brackish marsh levees then the value of the habitat is lowered, and the value of the small marshes is lowered because they are isolated from each other.

Literature Cited

Fisler, G. F. 1965. Adaptation and speciation in harvest mice of the marshes of San Francisco Bay. Univ. Calif. Publ. Zool. 77:1-108.

Geissel, W., H. Shellhammer, and H. T. Harvey. 1988. The ecology of the salt marsh harvest mouse (*Reithrodontomys raviventris*) in a diked salt marsh. Journal of Mammalogy 69:696-703.

Kovach, S. D., and W. G. Voight. 1986. Investigations on U.S. Navy lands in the San Francisco Bay region - 1985 Annual report. 35 pp.

Shellhammer, H. S. 1984. Identification of salt marsh harvest mice, *Reithrodontomys raviventris*, in the field and with cranial characteristics. Calif. Fish and Game 70:113-120.

Wondolleck, J. T., W. Zolan, and G. L. Stevens. 1972. A population study of the harvest mice in the Palo Alto Salt Marsh. 12 pp.